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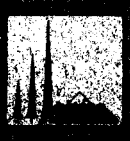
REPORT

QUARTERLY PROGRESS REPORT
A STUDY OF TUNGSTEN-TECHNETIUM ALLOYS
APRIL 1, 1966-OCTOBER 1, 1966

R. S. KEMPER
D. P. O'KEEFE

APRIL 1967



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A STUDY OF TUNGSTEN-TECHNETIUM ALLOYS
APRIL 1, 1966-OCTOBER 1, 1966

By

R. S. Kemper
D. P. O'Keefe

Metallurgy Department

April 1967

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A STUDY OF TUNGSTEN-TECHNETIUM ALLOYS

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INTRODUCTION

Technetium is a sister element to rhenium and has many properties that are similar to rhenium. It is predicted that technetium will have about the same effects on tungsten as rhenium in regard to increase in workability, lowered ductile-to-brittle transition temperature, and improved ductility.

The objectives of the current work are to recover technetium from fission product wastes at Hanford and reduce to purified metal; prepare W-Tc alloys containing up to 50 at.% Tc; fabricate the alloy ingots to sheet stock, assessing the effect of technetium on workability; and perform metallurgical and mechanical property evaluation of the fabricated alloys.

Previous reports have described the separation and purification of 800 g of technetium metal powder, melting of technetium and W-Tc alloys and some properties of the arc cast alloys.

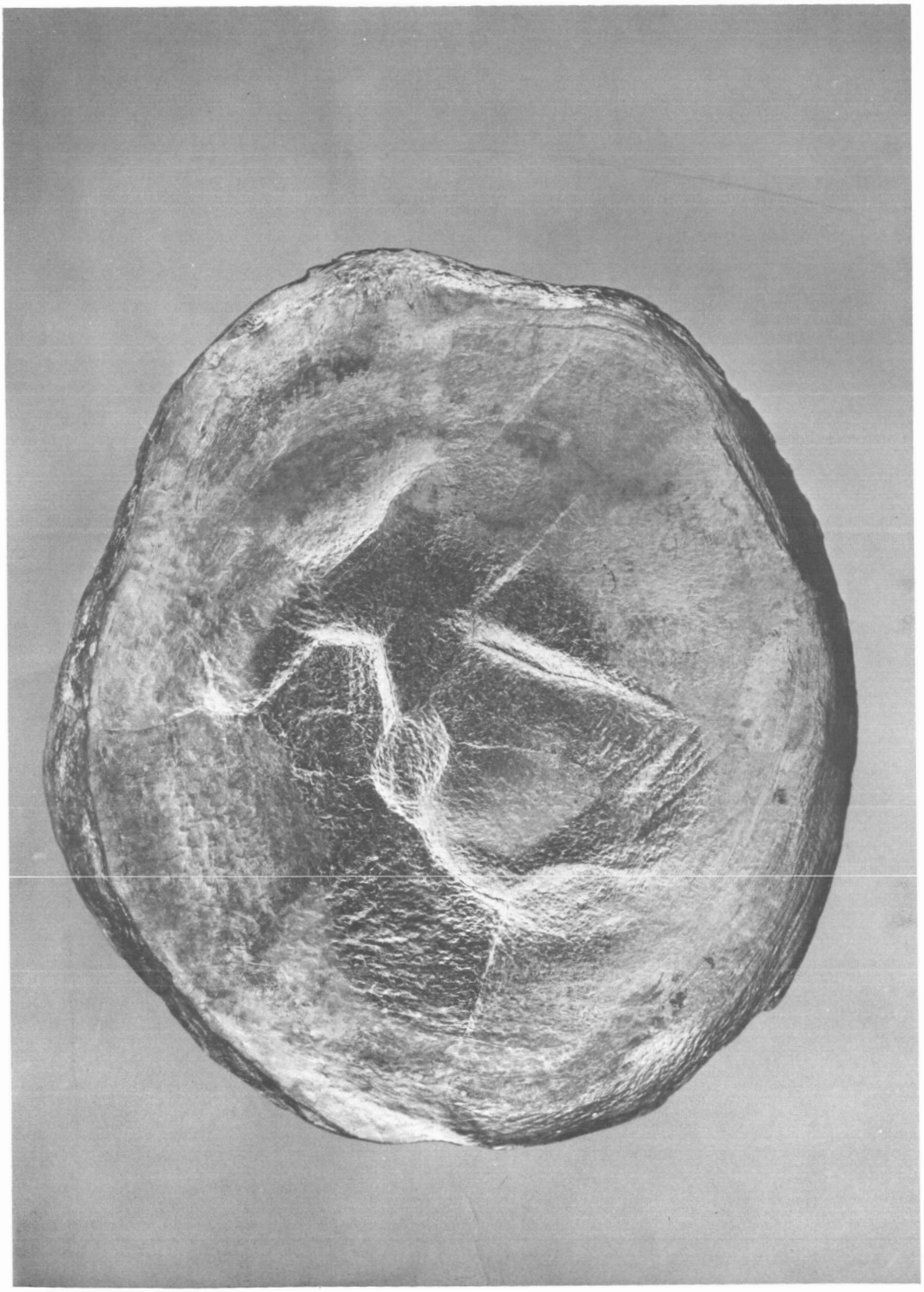
CURRENT PROGRESS

During the two quarters, the electron beam remelted alloys were forged while encapsulated in molybdenum cans; the protective can stock was removed chemically and examination was made of the material.

The buttons were individually sealed in molybdenum cans 1 1/2 in. OD x 1 1/8 in. ID x 3/4 in. overall height by electron beam welding. The end caps were 1/16 in. thick molybdenum.

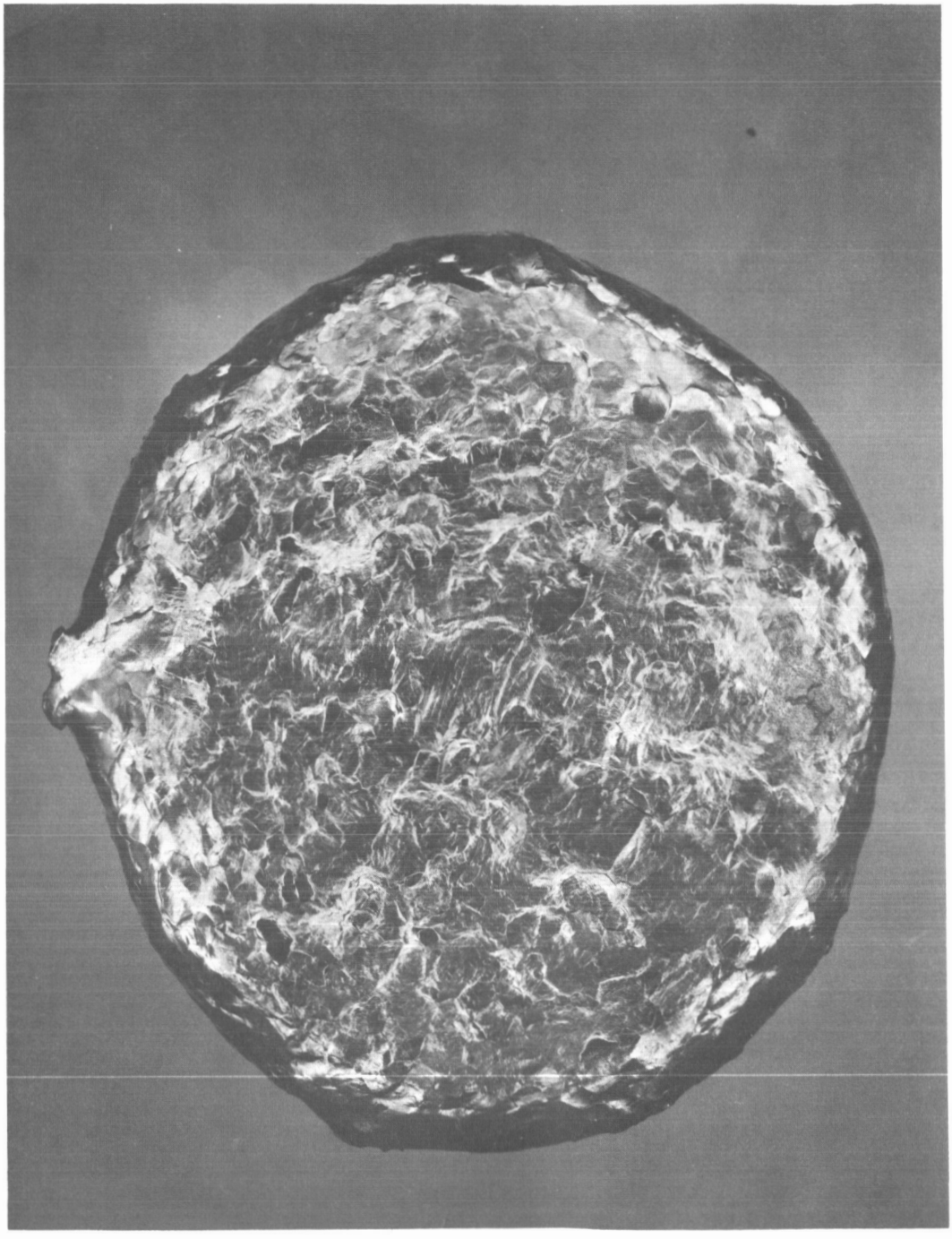
To heat for forging, the cans were placed in a molybdenum block in an induction coil in flowing argon. A forging temperature of 1675 to 1700 °C was selected for all the alloys. Temperatures were monitored by a W—W/Re thermocouple between the block and can, and a L&N optical pyrometer sighted on the can surface. The cans were placed on anvils in a 700 ton vertical hydraulic press and forged to 0.275 to 0.300 in. thickness in one press.

The 50 and 60 at.% Tc alloys fractured badly and penetrated the molybdenum can surface and caused some contamination problem. Small particles of the 60 at.% alloy were hard enough to be imbedded in the press anvil. All the alloys were chemically decladded by using an acid bath of $1H_2O$, $1HNO_3$, and $1H_2SO_4$. All the alloys were reduced by forging to 0.120 to 0.160 in. thickness except for one of the 10 at.% Tc alloys that was forged to 0.215 in. thickness. The surface appearance of the as-forged alloys is shown in Figures 1 through 16. The molybdenum was softer than the alloys at forging temperature which produced surface roughening on the forgings related to their grain size. The effect of technetium in reducing grain size is quite pronounced. It is interesting to note that approximately equivalent atomic percent technetium additions are required to produce the grain size effect observed in the W-Re alloy. Edge cracking was noted in alloys of 20 at.% Tc or greater, with the severity increasing with increasing technetium content. Severe breakup occurred in both the 50 and 60 at.% Tc alloys that previously had been identified as two phase alpha solid solution plus sigma. These forging results for the intermediate solid solution alloys are encouraging, and preparations are being made to further reduce the alloys by hot rolling to sheet of 0.050 in. or less thickness.



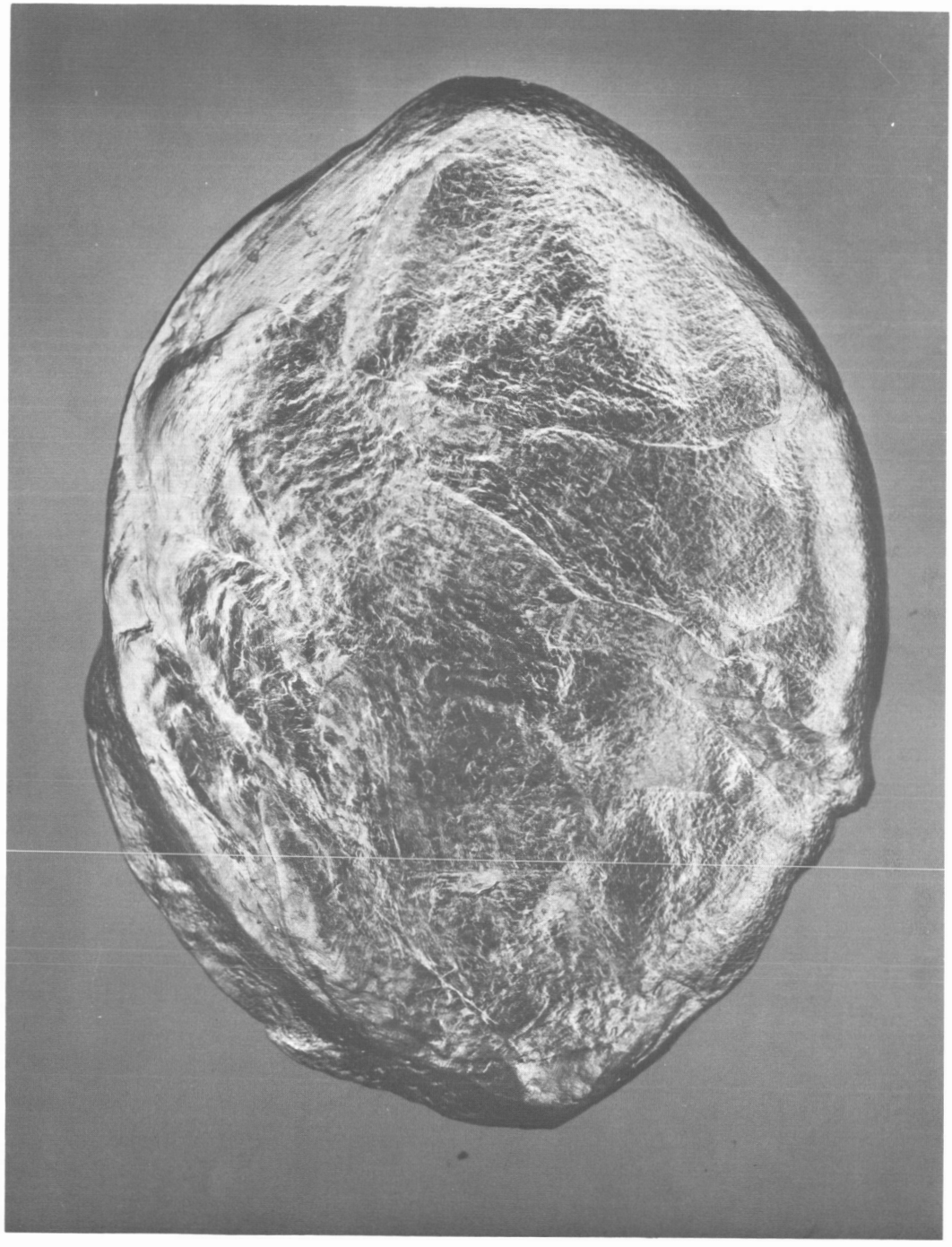
Neg 566-5186 5X

FIGURE 1. Tungsten as Forged; Approximately 60% Reduction - 1700 °C.



Neg 566-5180 *5X*

FIGURE 2. W—25 at.% Re as Forged; Approximately 60% Reduction - 1700 °C.



Neg. 566-5181 *5X*

FIGURE 3. W—2.5 at.% Tc as Forged; Approximately 60% Reduction - 1700 °C.

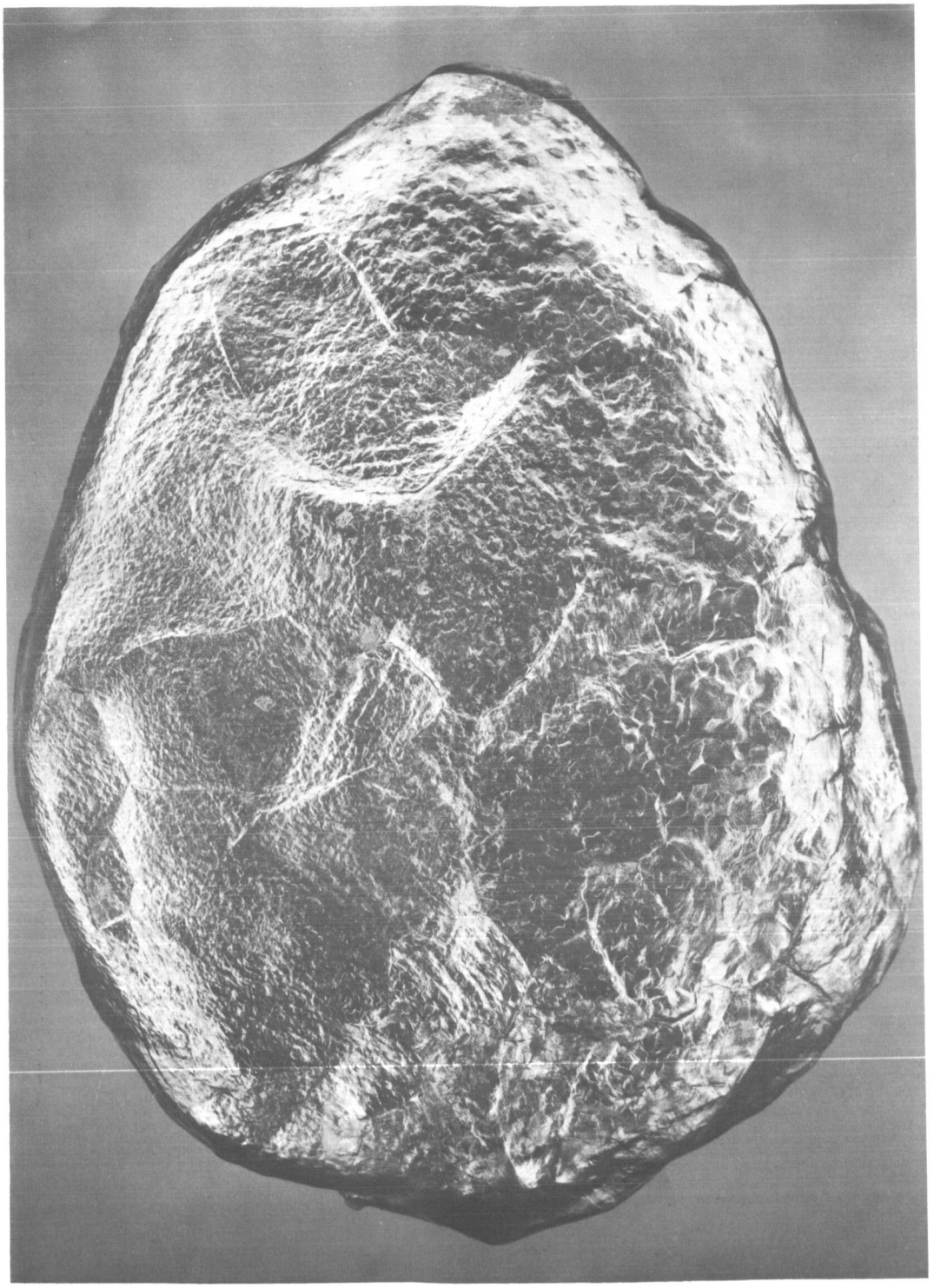


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FIGURE 4. W—3.5 at.% Tc as Forged; Approximately 60% Reduction - 1700 °C.

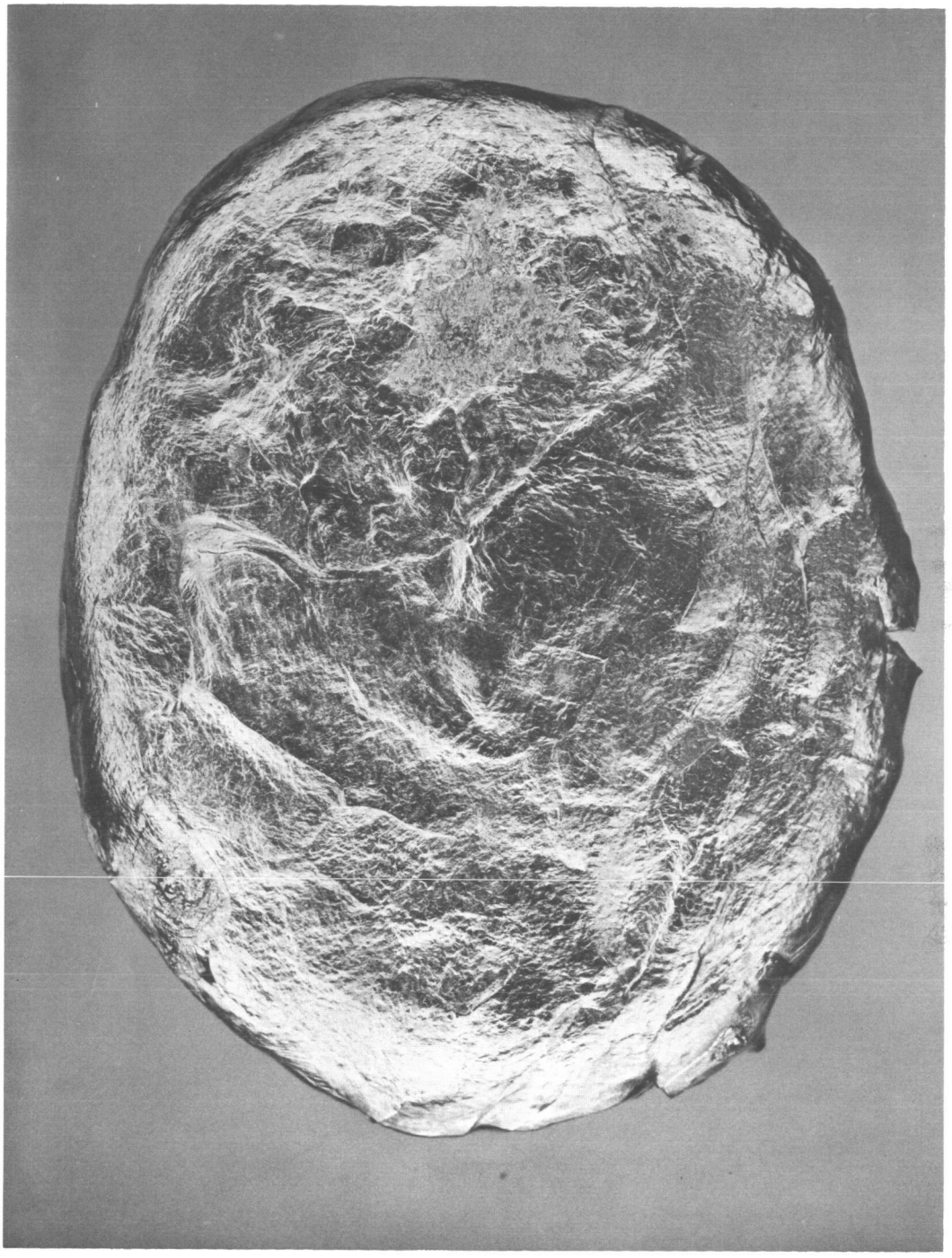

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FIGURE 5. W—5 at.% Tc as Forged; Approximately 60% Reduction 1700 °C.

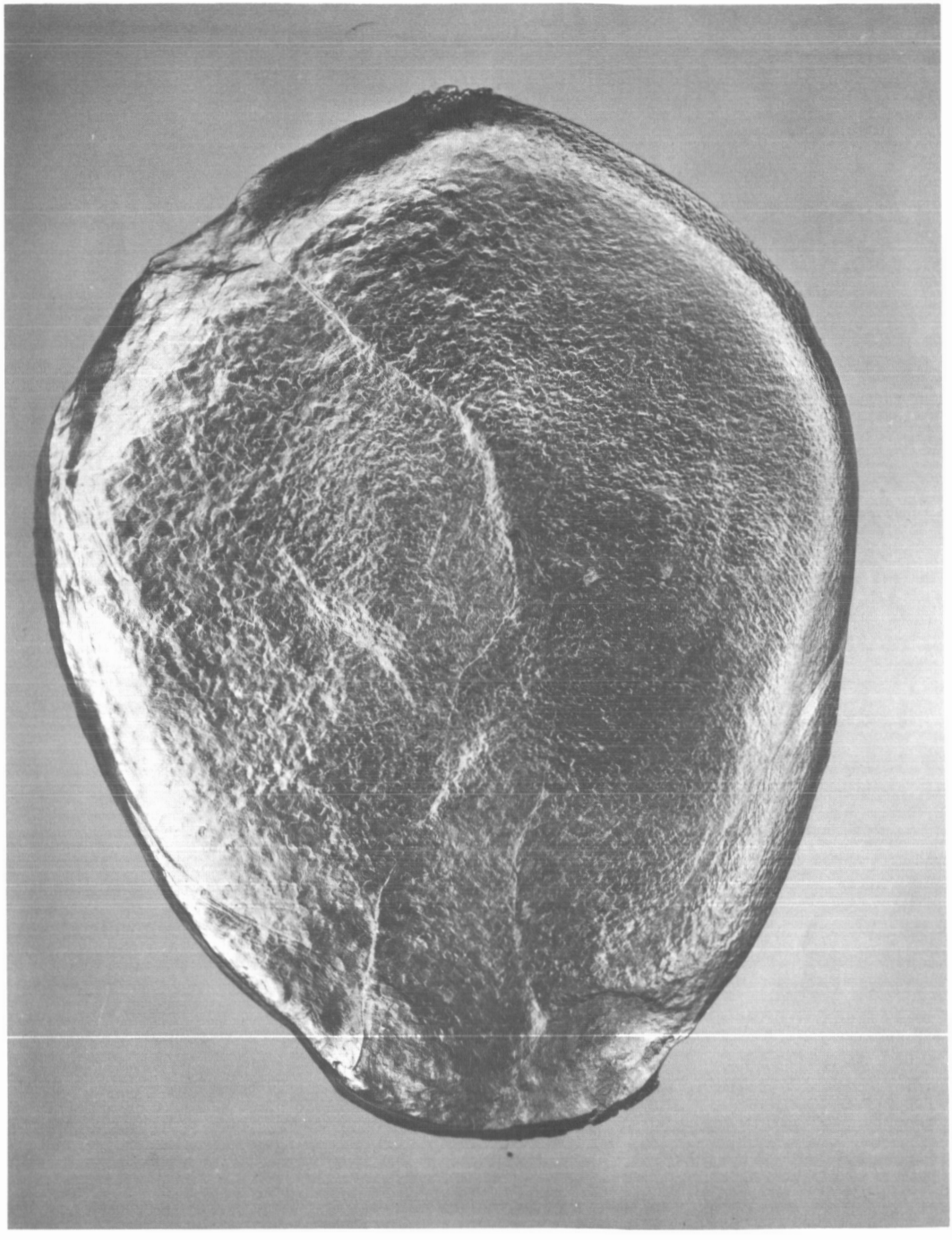

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FIGURE 6. W—5 at.% Tc as Forged; Approximately 60% Reduction - 1700 °C.

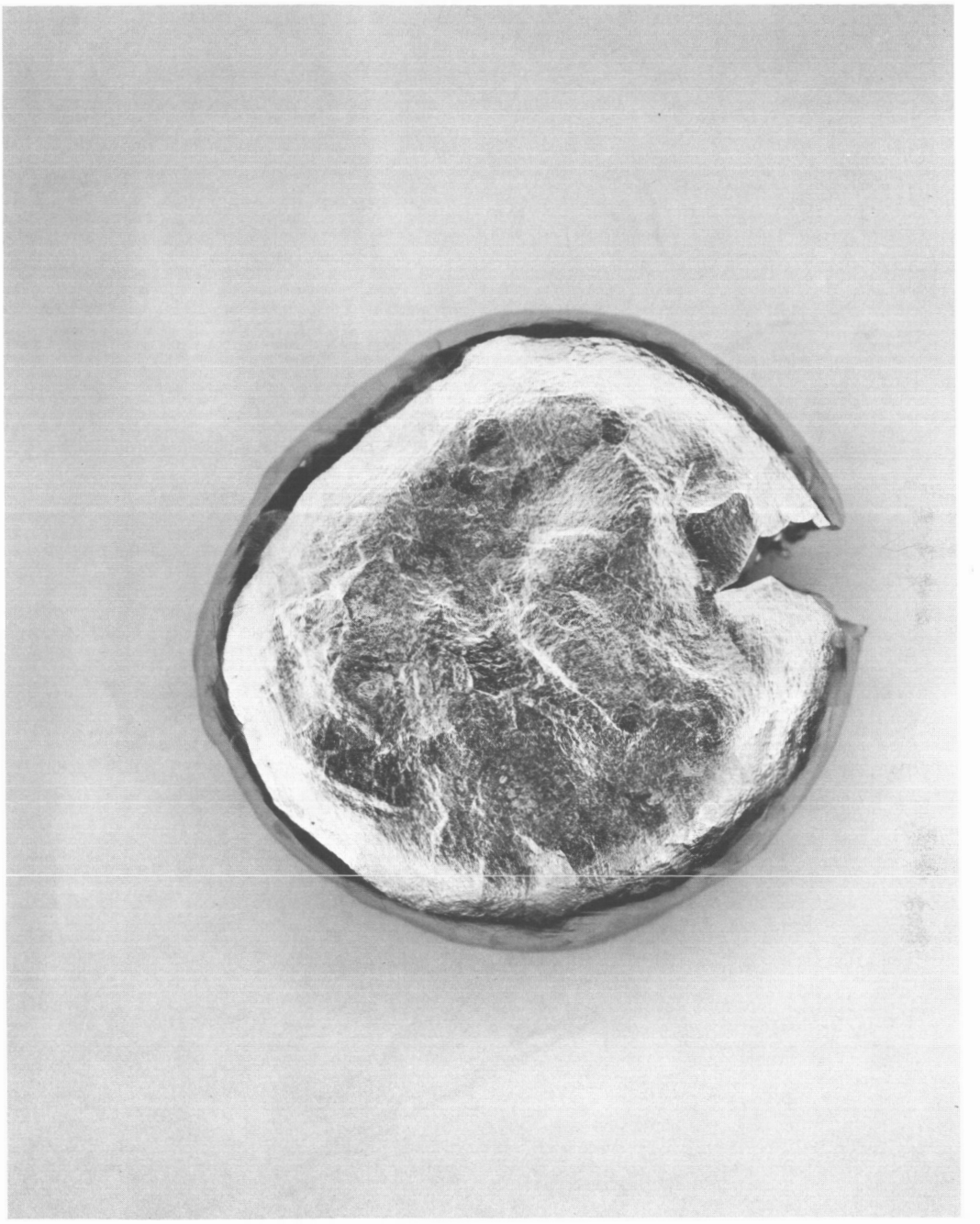

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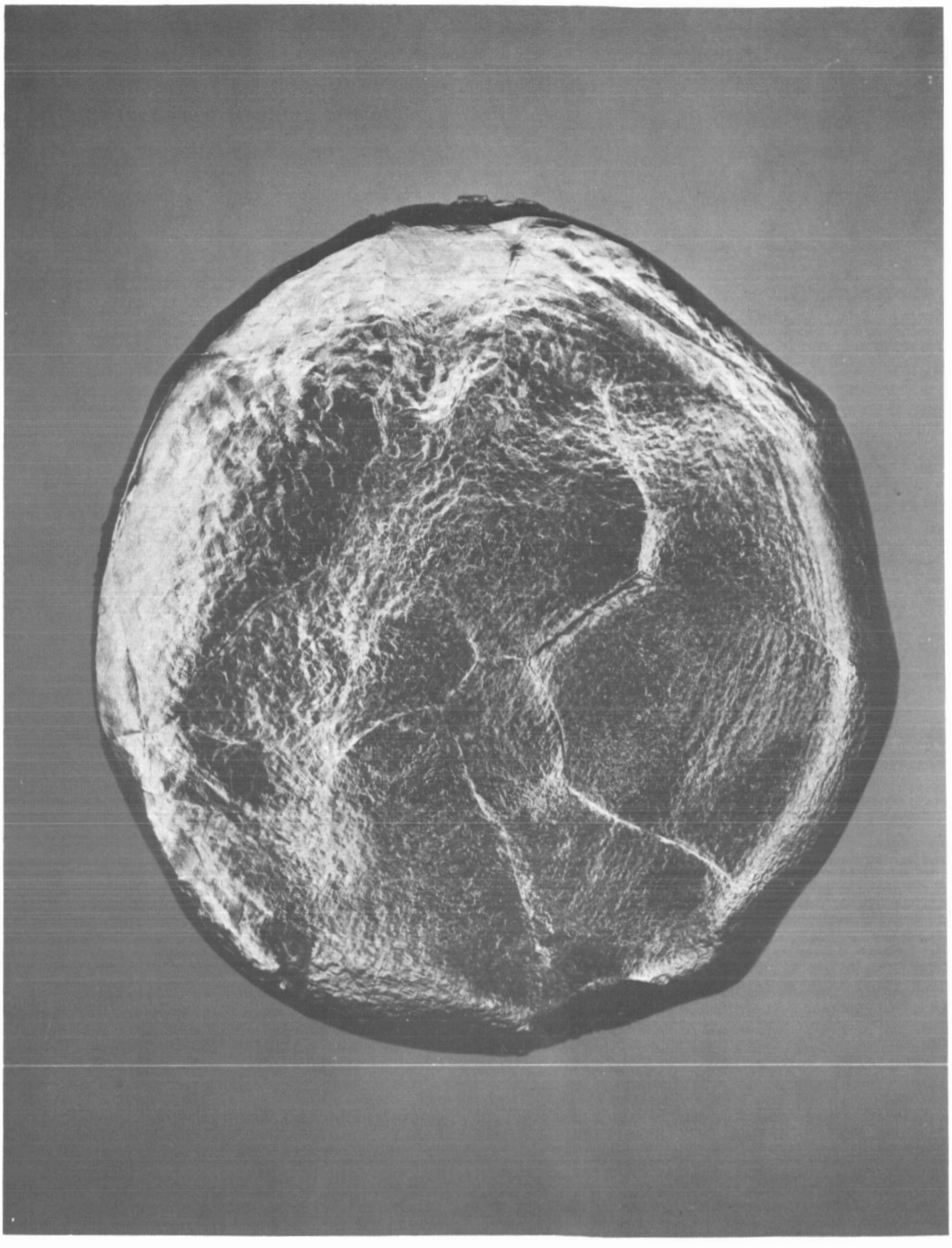
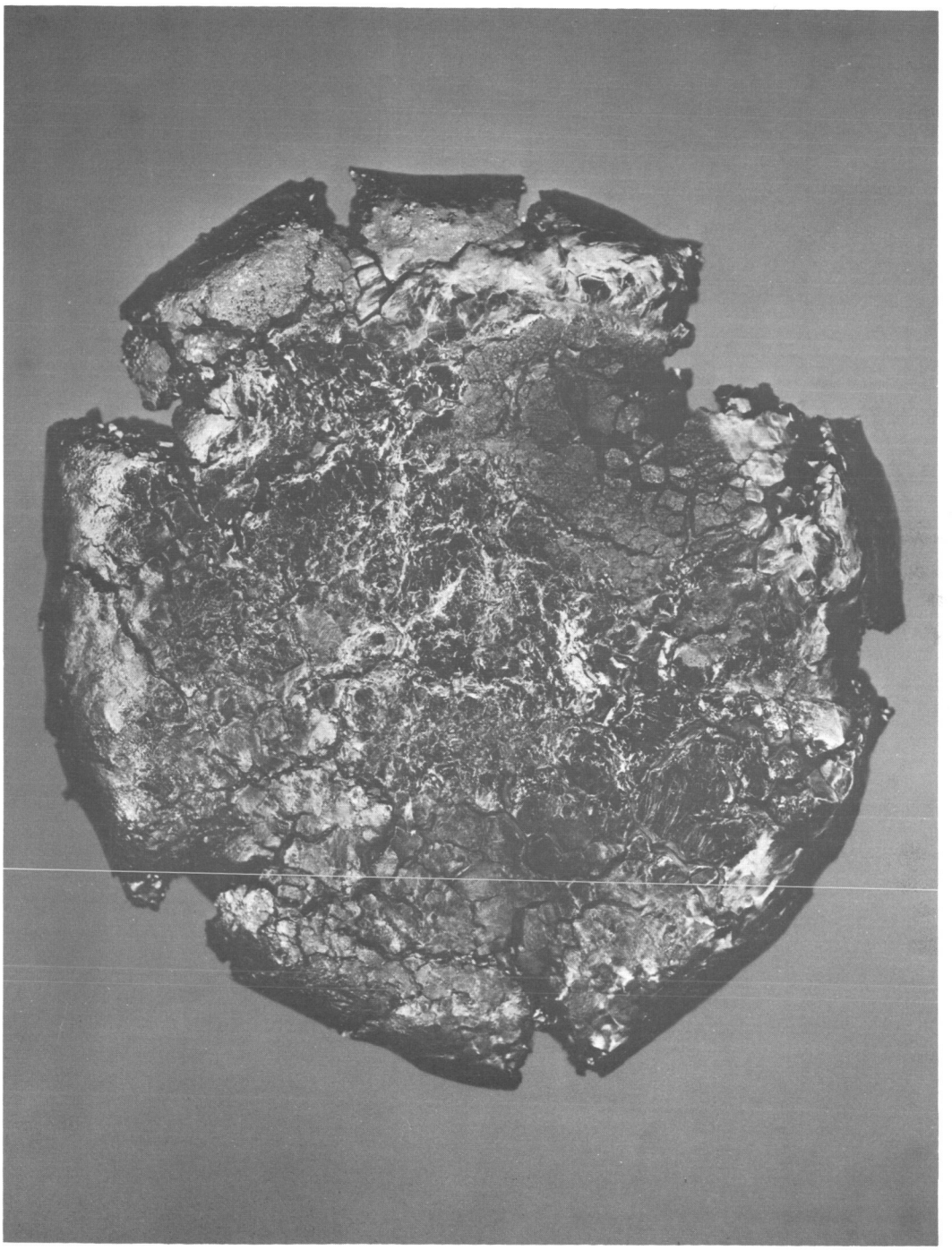
FIGURE 7. W—10 at.% Tc as Forged; Approximately 40% Reduction - 1700 °C.



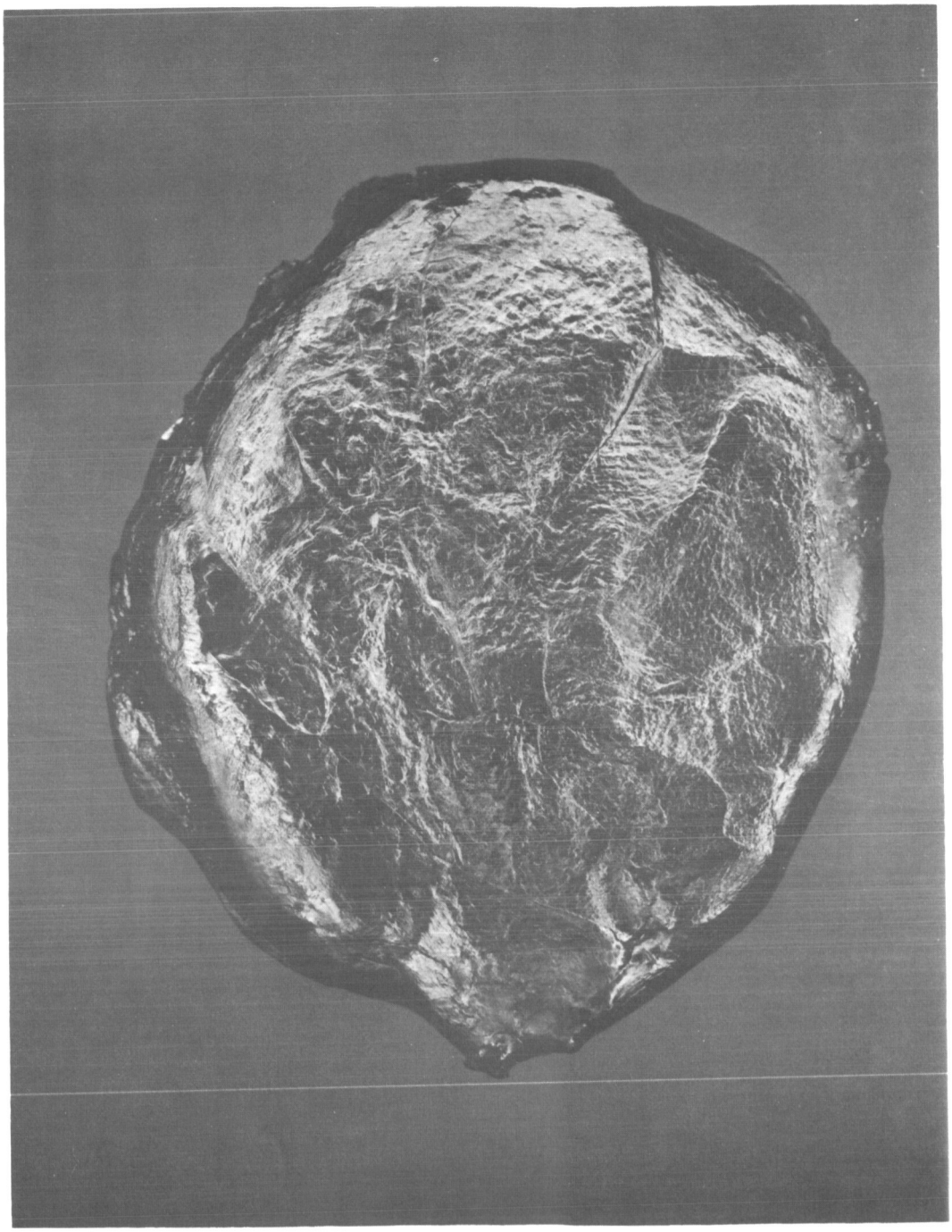
Neg 566-5187 *5X*

FIGURE 8. W—10 at.% Tc as Forged; Approximately 60% Reduction - 1700 °C.



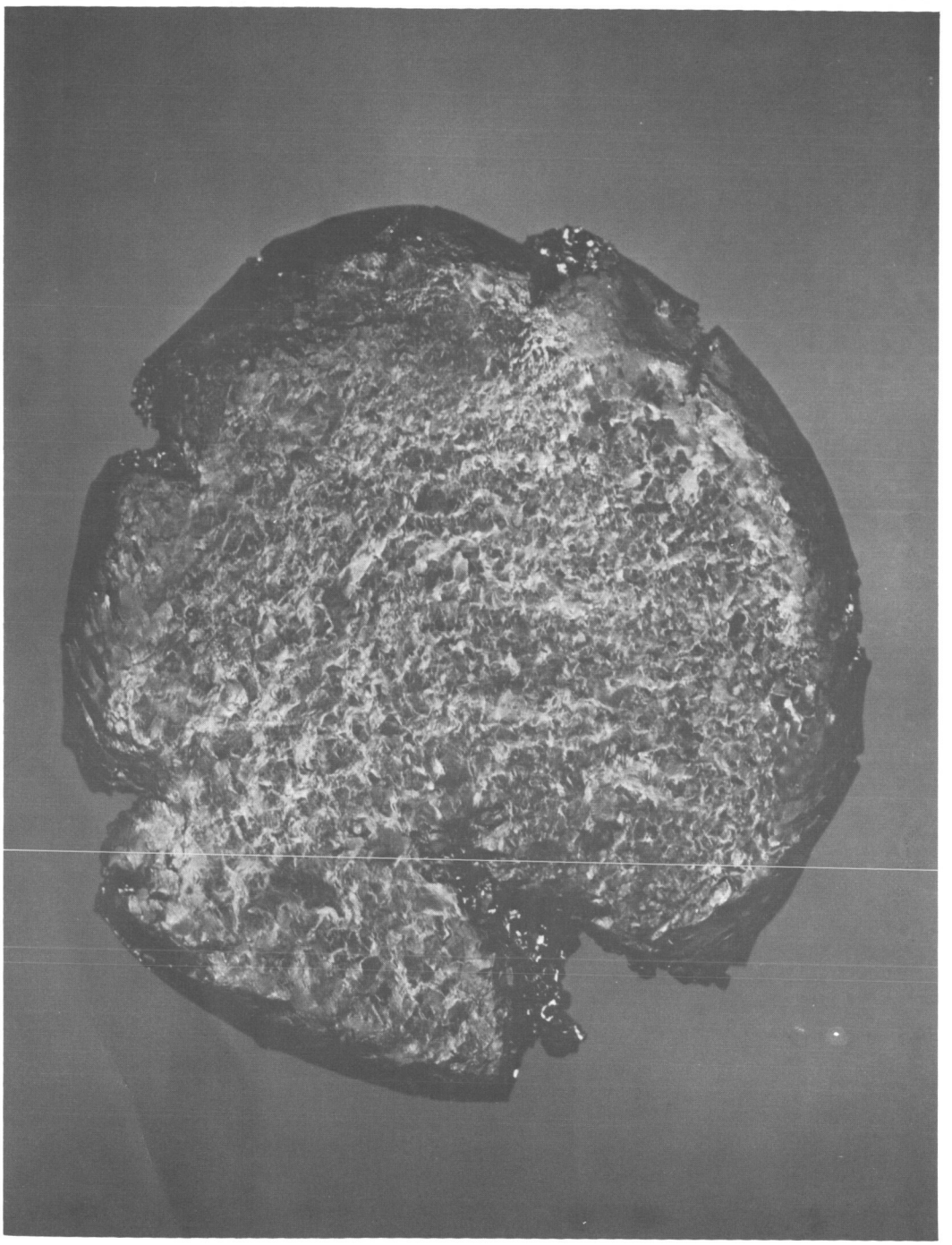
Neg 566-5188 *5X*

FIGURE 9. W—20 at.% Tc as Forged; Approximately 60% Reduction - 1700 °C.



Neg 566-5189 *5X*

FIGURE 10. W—20 at.% Tc as Forged; Approximately 60% Reduction - 1700 °C.



Neg 566-5190 5X

FIGURE 11. W—30 at.% Tc as Forged; Approximately 60% Reduction - 1700 °C.

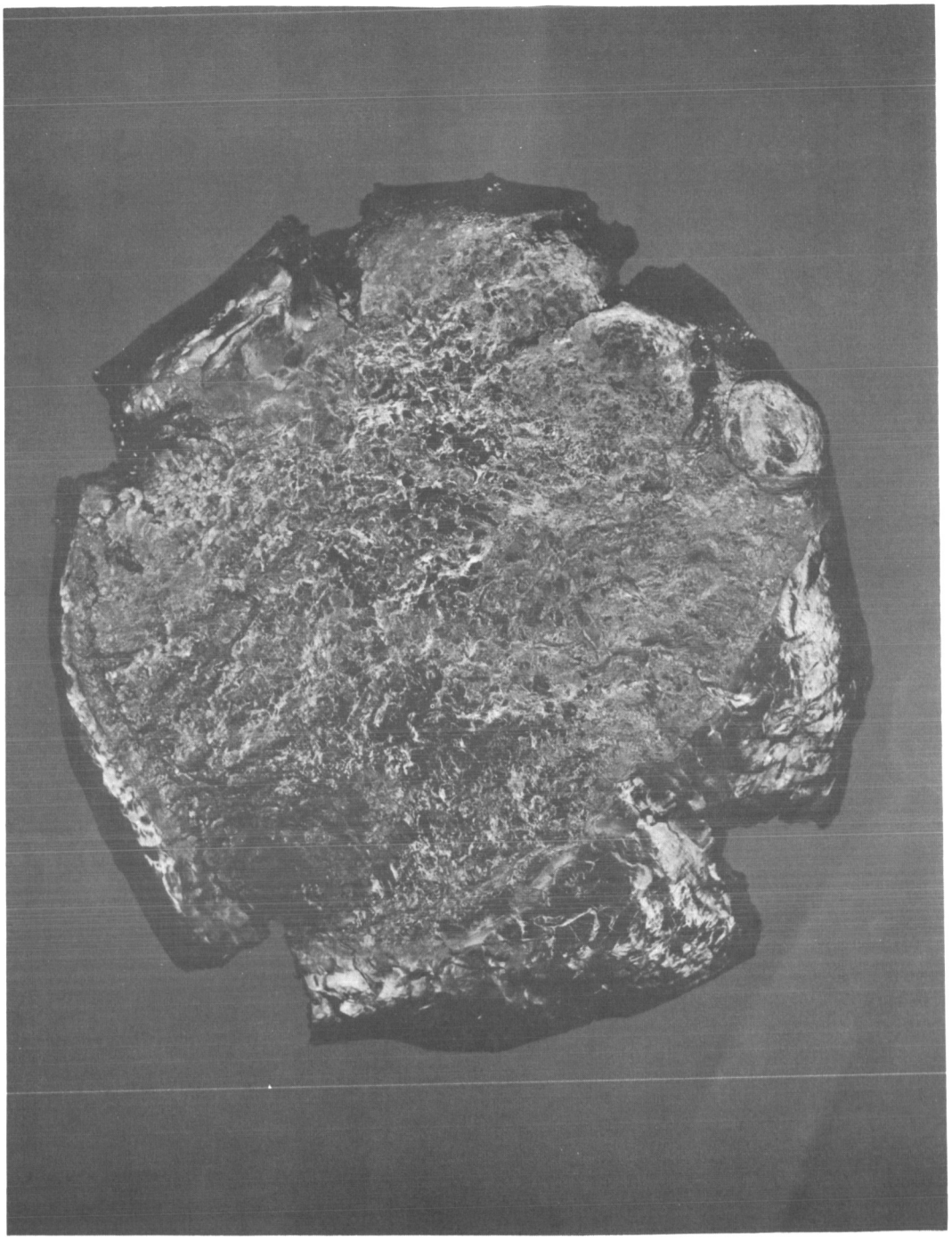


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FIGURE 12. W—30 at.% Tc as Forged; Approximately 60% Reduction - 1700 °C

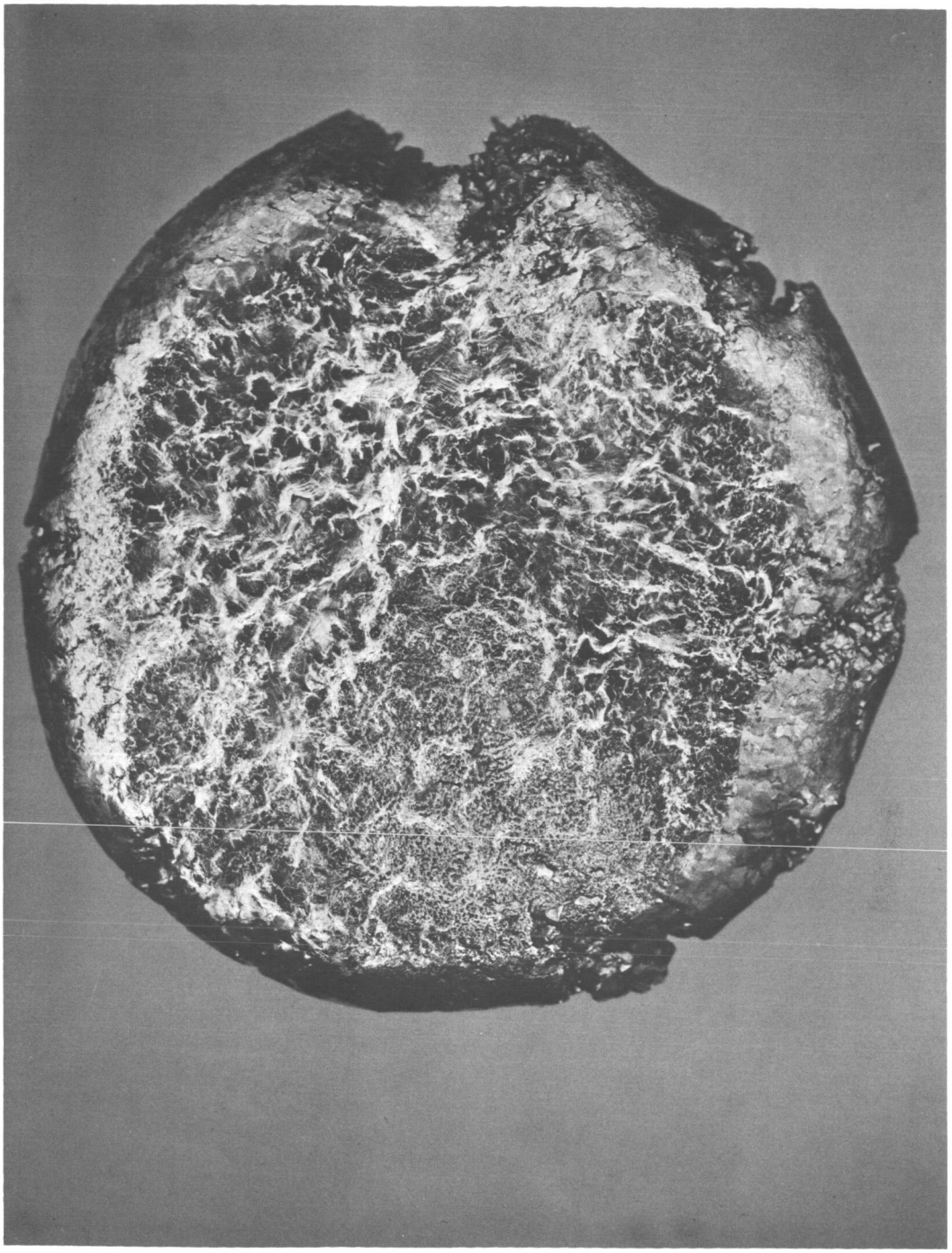

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FIGURE 13. W—40 at.% Tc as Forged; Approximately 60% Reduction - 1700 °C.

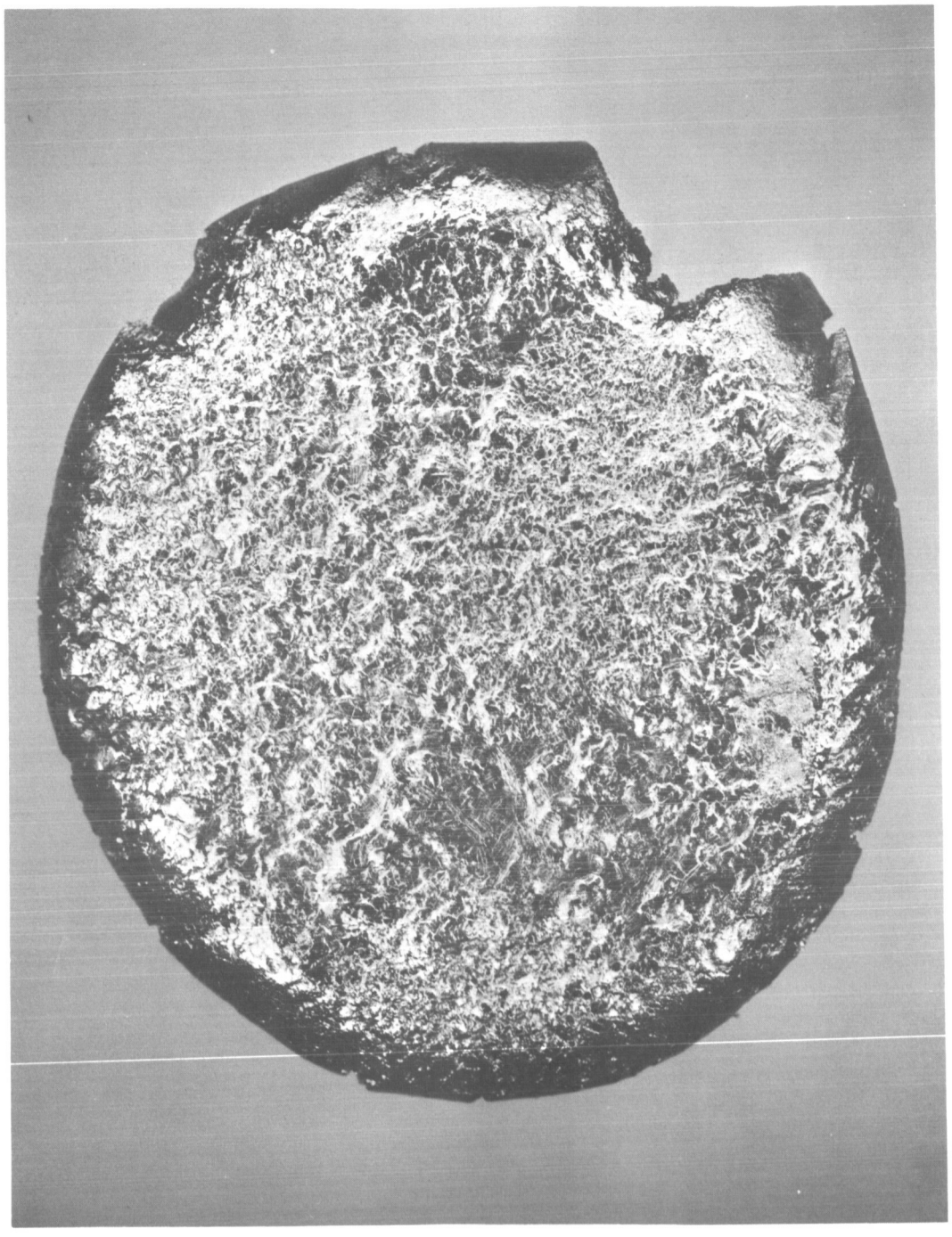

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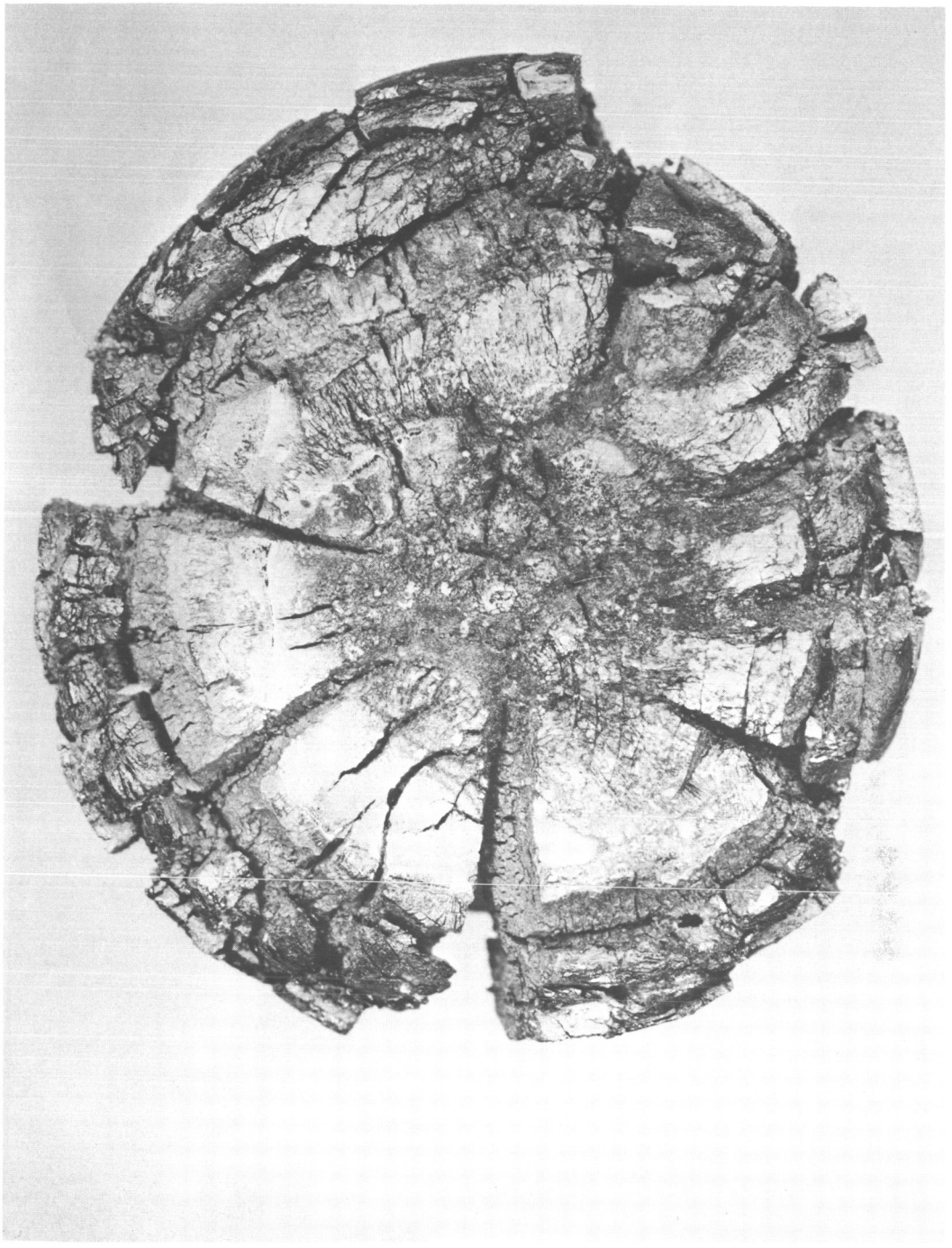
FIGURE 14. W—40 at.% Tc as Forged; Approximately 60% Reduction - 1700 °C.



Neg 566-5194 *5X*

FIGURE 15. W—50 at.% Tc as Forged.

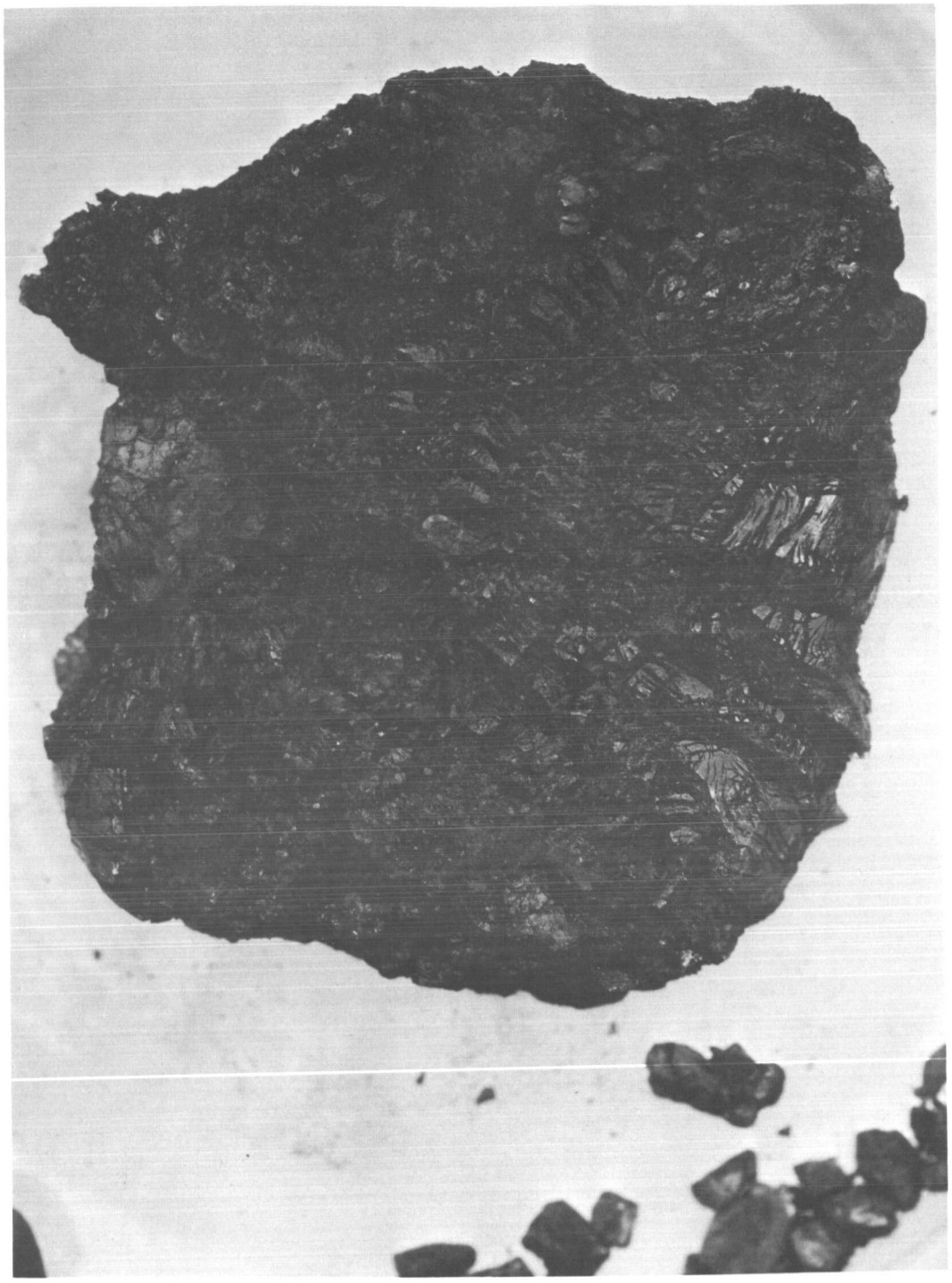


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FIGURE 16. W—60 at.% Tc as Forged.

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